

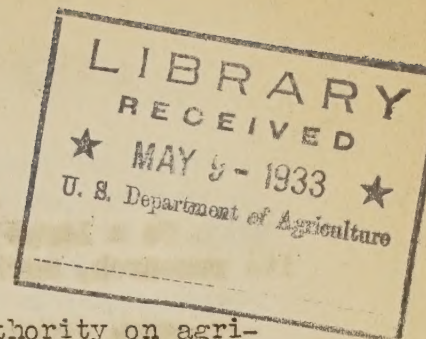
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SOME ACCOMPLISHMENTS OF THE  
UNITED STATES DEPARTMENT OF AGRICULTURE



The late Sir Horacé Plunkett, Ireland's great authority on agriculture, described the United States Department of Agriculture as "the most useful institution on earth." This is a bolder claim than any that the Department itself would make; the eminence of its source, however, shows that it is not fantastic.

The worth of the Department's work is not to be judged by the prevailing level of prosperity. The Department has won its position as a public service institution by scientific triumphs and practical help to agriculture, industry, the home and the community in general - in good times and bad times. In its multitudinous tasks, some are naturally of minor importance. Critics frequently single out one of these, distort it as characteristic of everything the Department does, and ignore the big things. Time and again the Department's scientists have made discoveries that seemed small at first, but turned out to be profoundly significant.

It is alleged that the Department does many things which the individual should do for himself. Actually, the Department specializes in services which individuals can not do for themselves, but which are nevertheless of tremendous value. It does not tackle jobs that the individual should do for himself. Its governing principle and fundamental purpose are to do necessary things that would otherwise not be done.

Such things become more numerous as society grows more complex; but the principle remains unchanged. The Department of Agriculture may have explored fields occasionally which proved to be relatively trifling, but by and large it has confined its activities to fields that are necessary, and beyond the reach of private initiative. It has done this with real economy. The Chairman of the House Committee on Agricultural Appropriations, after searching scrutiny, said several months ago: "From my investigation, I believe this Department is one Department of the Government that has cooperated with the President 100 per cent. in striving to reduce expenses."



### Largely a Research Institution

To a large extent the Department is a research institution. Through its research, agriculture and industry have reaped enormous benefits.

Scan first some of the older victories. Research in the Department from 1888 to 1893 proved that a microorganism found in the blood of cattle is the cause of splenetic fever, and that the disease is transmitted by the cattle tick. This was the first demonstration that a microbial disease can be transmitted exclusively by an insect host or carrier. The beneficial results were literally stupendous. They were not limited to an improvement in the health of cattle. The discovery ranks among the great achievements of medical science; it led to the knowledge that such diseases as yellow fever, malaria, typhus fever, African sleeping sickness, Rocky Mountain fever, and other maladies are similarly transmitted. It made possible the control of yellow fever in the Canal Zone.

Scientists in the Department discovered in 1903 that hog cholera is caused by a filterable virus, and developed a preventive serum that saved a threatened industry.

Research in the Department discovered an effective remedy for hookworm in human beings, vastly extended the shipping range of citrus fruits, rehabilitated the disease-threatened sugar cane industry, protected the potato industry, and found uses for numerous farm by-products. These are merely examples.

### Achievements in Plant Studies

The development of new varieties of plants and the introduction of foreign varieties to American soil has made it possible better to utilize our land resources. Pima cotton, for example, was developed by selection from cotton originally brought from Egypt. Pima is of great length and strength and is now grown in the Salt River Valley of Arizona. Hardy alfalfas have been brought from Siberia and other parts of Asia, the soybean from the Orient, Sudan grass, Rhodes grass, Napier grass, velvet bean, and purple vetch from Africa and elsewhere. We are indebted to Russia for Durum wheat. Sudan grass now has an annual value of over \$2,000,000 in this country. The Washington Navel orange, introduced from Brazil in 1872, which now makes up the bulk of the California orange industry, is only one example to show how American orchards and groves have been enriched by the introduction of scores of fruits and nuts from abroad. Through numerous investigations, the Department has improved this orange and perpetuated the best qualities through bud selection. In more recent years there has been added the date, the alligator pear, the mango, Chinese and Japanese persimmons, the papaya, and the Pistache nut.

Even more important than the breeding and bringing in of new plants is the discovery of new principles such, for instance, as that of the improvement of the quality of fruit and the yield by means of bud selection mentioned in the preceding paragraph. Contrary to popular belief, plants propagated from buds, scions, and cuttings, instead of reproducing the



parent plant in minute details, frequently show more or less variation, which, if not controlled in subsequent propagations are likely to reduce materially their value for commercial purposes. The discovery of a means of counteracting the tendency toward retrogression in the case of orange, lemon, and grapefruit trees through the careful selection of propagating wood from parent trees of proven worth has made it possible to transform unproductive trees into productive ones and to increase the yields of the citrus groves of California, as well as other crops which are vegetatively propagated.

Methods of growing cotton have been considerably modified in recent years by the new method of thick spacing of "single stalk" plants, based on a technical botanical discovery that the cotton plant has two distinct kinds of branches. The single stalk cotton is earlier and more productive, especially under boll-weevil conditions or in short seasons. The yields are often increased from 10 to 30 per cent, or even from 50 to 100 per cent under some conditions, by the new method.

A more recent fundamental discovery is that the flowering and fruiting of plants are greatly influenced by the length of the day. It is not the approach of cold weather nor the age of a plant that determines when it shall bloom or form fruit; the stimulant that causes these phenomena is the gradual change in the length of the day. When this principle was announced, it produced a sensation among scientists all over the world. The time of blooming of flowers in greenhouses can be controlled, and in plant breeding work it is now possible, because of the control of blooming by shortening the day artificially with dark rooms, to cross-pollinate plants that in the past could not be crossed. Plants from different latitudes can be bred together.

#### Varied Applications of Research

Every day the world is learning new things from research scientists of the Department of Agriculture. To name them all would require volumes. The mention of a few, briefly, indicates the vast scope of the work performed.

The discovery of the part played by the common barberry bush in the life of the black stem rust of wheat has made it possible to check this worst enemy of the wheat crop. Natural enemies of pests have been imported to eradicate the pests. Clover has been saved from the clover seed midge by a slight modification in cultural practice; fruits have been saved from the San Jose scale; the house fly is being conquered; bark beetles, usually found in coniferous forests, are being eradicated; means have been found for contending successfully with the grape rootworm which might have destroyed an industry worth twenty million dollars a year; the alfalfa weevil is being conquered; the extreme mortality rate among colonies of bees has been cut down by the knowledge entomologists have gained concerning the enemies of the bees; special poisons have been concocted for various rodents and predatory animals; animals and birds have been classified according to whether they are destructive or beneficial.



Work on the kiln-drying of wood was started by the Forest Service of the Department some twenty years ago. Little was then known of the underlying principles of wood seasoning or of practical methods of drying wood. Research developed an understanding of the manner in which wood dries out, and of the specific causes of various drying defects. Methods of determining and correcting these defects have been applied commercially. Under normal conditions about 20 billion feet of lumber are kiln dried in the United States annually. Seasoning losses, preventable and unpreventable, that occur during the kiln drying process average several dollars per thousand feet. Losses from the use of wood not properly seasoned are of similar magnitude. Research in the Department has helped greatly to reduce these losses. It has also made possible the kiln drying of many species and grades of wood formerly not considered capable of being satisfactorily kiln dried. This country is much further advanced in the kiln-drying art than any European country. It is estimated that about half the wood annually kiln dried in the United States is dried by improved methods based on the findings of this Department. This annual saving is estimated at approximately \$10,000,000.

Tests of shipping containers at the Forest Products Laboratory resulted in the development of special testing appliances which permit the observation and study of containers meeting the hazards that actually arise in shipment. Methods were developed for making more serviceable wooden boxes and crates, and for improving other types of containers. Wide adoption of the principles thus worked out effected important savings, the aggregate of which for the period 1920-1925 was estimated to exceed \$65,000,000. Some twenty-five commercial concerns have installed container-testing apparatus similar to that developed in the Department's laboratory.

Millions of feet of lumber used in manufacturing various articles are bent to different forms. The breakage losses frequently exceed 25 per cent of the material, and the labor loss is additional. Study of bending methods by the Department showed that it is possible to reduce the loss by at least fifty per cent.

In the highway engineering field Department research has supplied the basis for revolutionary changes in the design of highways to enable them to stand up under an enormously increased traffic. It has shown the nature and magnitude of the destructive forces of weather and traffic which tend to break down the road structure and has indicated types of material and methods of construction which will resist these forces. Through studies of the disposition and control of construction crews the Department engineers have also shown, in detail, how the cost of grading and building concrete highways can be reduced by 25 per cent or more.

Nearly a billion acres of the agricultural lands of the United States have been mapped and classified during the more than 30 years the Soil Survey of the United States Department of Agriculture has been at this task. The work is now progressing at the rate of more than 15,000,000 acres each year. The soil survey has much more practical use than a mere



statement of soil types. It is valuable to the farmer because with it he can know what crops will do best on his land, what soils are best suited for crops and what should be left in pasture. It is valuable to the land seeker who wants land in a location unfamiliar to him. Road engineers and manufacturing concerns such as canners, cement and brick makers frequently consult soil maps before locating in a territory. Schools and county agents use the soil maps to advantage in their work. Experiment stations find them helpful in advising farmers. Experiment station results obtained on one type of soil might not apply to a different type of soil. For this reason, the surveys help determine the location of experiment stations and demonstration farms. Public health offices use them in connection with sanitary surveys and find them helpful in investigations of a community scope. An outstanding use of soil maps is that made by land banks and insurance companies in connection with loans on land. Use of the soil map in some regions in this connection has become almost standard practice.

### Prevention of Soil Erosion

Extensive field work by the Bureau of Chemistry and Soils has served to call attention to the fact that the topsoil of most farm lands is not nearly so deep as generally has been supposed. Of 172 soil samples, representing 115 important types of farm land (nearly all of them erosive uplands), collected from 34 States, only 7 samples showed a topsoil as thick as 16 inches. The average depth of the topsoil represented by the 172 samples was only 9 inches. Some of these soils are being washed away at the rate of 7 inches--which in some instances exceeds the total depth of the topsoil--in about 30 years, and others at the rate of 7 inches in 35, 40, or 50 years, and so on. In losing this important layer, which not only contains the bulk of the soil humus and beneficial organisms but, undoubtedly, a considerably larger amount of available plant food than the unweathered, raw subsoil, it is obvious that the farmer on this land is losing his principal capital.

Such losses in the course of a few years run into hundreds of millions of dollars. To check these losses the Bureau of Chemistry and Soils cooperating with the Bureau of Agricultural Engineering is now demonstrating practical and effective methods of preventing rain wash and gullyng at ten erosion prevention stations in ten important farming regions of the United States. At these stations the building of terraces, the planting of strip crops, the building of "living" sod dams, and other practical methods of erosion prevention are being perfected and demonstrated to thousands of farmers who are also shown the devastating action of erosion by the actual measurements of soil wash on soils under different systems of management and for the different soil types.

### Utilizing Farm By-Products

The little tomato seed was a waste of the catsup industry until chemists found a way to extract its oil. Today this oil is used as food and in making fine soaps. The kernel of the seed of the apricot was a waste of the apricot industry until chemists found a way to remove its bitter principle. Today the apricot kernel, tasting nearly like the almond, is used in flavoring macaroons. The seeds of the raisin were a waste with the seeded raisin industry until chemists found a way to use them. The oil of the seed is comparable in taste with the raisin, and work is now being done in spraying this oil on the seeded raisins to keep



them soft and fresh until consumed.

In these days of rapidly moving evolution in industry the humble and little-respected by-product of today may be a main product tomorrow. The manufacturing industries can show hundreds of examples: The corn-starch industry started out to make cornstarch for cooking and laundering. Then science showed how to make glucose from the starch. Then someone conceived the idea that the oil of the germ had attributes of the comparatively costly imported olive oil. Today glucose, corn sirup, and corn oil are main products of the corn refining industry. There was a time when this industry dumped into the river all of the corn kernel that was left after the starch had been removed. Today these formerly utterly wasted by-products are livestock feed, selling for well up into the millions a year.

Our immense fruit and vegetable canned-food industry had its beginning in the home and was perfected in the scientific laboratory and in the canning plant. At first the purpose of the canning was to save something out of the losses from surpluses and low prices. Today the canned article is a main product, with thousands of acres of land and factories devoted to canning crops.

The so-called semi-chemical process developed at the Forest Products Laboratory of the Department for the manufacture of paper and board makes it possible to obtain yields of more than 70% of the weight of the wood as compared with yields of from 40 to 50% by ordinary chemical processes. The process is now used by at least five mills in manufacturing corrugated and fiber board from extracted chestnut chips, heretofore a waste product. The quantity involved is over 100 tons daily. The process is also used in making light colored wrapping paper from red gum trees.

Cotton is nearly pure cellulose. The chemist already knows how to make rayon and artificial silks out of cellulose from cotton linters, cornstalks, etc., and industries of great size have sprung up to manufacture them. Who can imagine the future in store for the humble and lowly cornstalk? Farm journals have been printed on paper the most costly part of which had been replaced by cornstalk pulp. Insulating and building board is made of cornstalks, some as porous and light as cork and some almost as hard and dense as iron. Who can say now, in view of the industrial beginnings already made, what part cornstalks will play in the building construction and heat and cold insulation of the future? Some day our books and daily news may come to us on cornstalk paper.

Bagasse is the pulp of the sugar cane left after the extraction of the cane juice. The sugar mills formerly used it as fuel for the mills. Not long ago the idea was conceived of manufacturing this bagasse into insulating board. Today an enormous business stands as a monument to that idea, to the ingenuity of private business, and to the cooperation of the United States Department of Agriculture and the capacity of its scientists.

Chemists of the Department have found that by the use of low-priced nitric acid a high grade cellulose, the base material for rayon, may also be produced from bagasse. The process is important to rayon producers as it indicates a large new source of raw material, available each year.



Most rayon producers now depend upon wood pulp for cellulose.

In the Bureau of Chemistry and Soils where much valuable work has been done in the utilization of agricultural by-products, there is a small bottle of a brownish cellulose substance called lignin, which was derived from the corn plant. Lignin is one of the principal parts of woody plant tissues. Lignin possibly may yield as many products of commercial, chemical, and medical importance as have been yielded by coal-tar, that by-product of the manufacture of coal gas, the study and exploitation of which gave to Germany a preeminent position in the world chemical trade. The Department's chemists say that lignin may possibly yield even more than coal-tar. Some of the articles made from coal-tar that are of great commercial importance are aniline dyes, phthalein dyes and other phthaleins, indigo, carbolic acid, creosote, flavoring extracts, and drugs and chemicals of many kinds. The Bureau of Chemistry and Soils has already made dyes from lignin which are more fast than the first aniline dyes made from coal-tar. And the chemist has gone scarcely below the surface in the exploration of lignin. Millions and millions of tons of by-product stalks, cobs, and straws are produced on our farms every year and every ton holds its store of the mysteries of lignin and cellulose - and who knows what else?

Then there is furfural, which can be made from a number of the woody cellulose by-products of the farm, corn cobs and oat hulls being very good sources. Furfural formerly was imported from Germany, as a chemical curiosity, at \$30 a pound; today, as a result of work done by the Bureau of Chemistry and Soils, it is manufactured in this country to sell as low as 10¢ a pound. One of the largest oat processing concerns in the country is now making large quantities of furfural from oat hulls and selling it to manufacturers of resins, paints, lacquers, etc.

For generations the cotton farmer has had as his main business the production of an industrial inedible fiber for the textile mills. At the time of the Civil War the by-product cottonseed, except the small quantity saved for planting, was practically waste; in 1870 it was used for fertilizer; in 1880 for cattle feed; and in 1890, thanks to the chemist and his research, a cotton-oil industry came into being. Cottonseed oil is used in cooking and for many other purposes.

A by-product may even have by-products of its own. In pressing the cottonseed to extract the oil the cottony fuzz on the seed was a nuisance. This fuzz is called linters. Today we have a great industry which makes a product out of linters that looks and feels like silk. This is an accomplishment of the research chemist, made in the chemical explorations of cellulose. Linters have become so valuable that the seed is sometimes scraped so close that it looks as if it had been shaved with a razor. Linters were first used in making mattresses, batting, high explosives (nitrocellulose), etc. Today they are used to make the finish and tops for our automobiles, substitutes for leather, brushes, combs, and mirrors, camera films - including our movies, casings for sausages, fine paper, collodion for skinned fingers, etc.

A few years ago the citrus growers of California, particularly the lemon growers, found themselves in a serious situation. They were loaded down with the burden of crop surpluses. There seemed no way out but ruin.



Leaders of the growers asked the United States Department of Agriculture for help, and obtained from the Department the services of a horticultural expert. The growers gave him free rein to supervise their industry. One of the first things this expert did was to try to find ways of utilizing the surpluses, which consisted of good but over-sized and odd-shaped fruits, the removal of which to waste dumps had been costing the growers a dollar a ton. The Bureau of Chemistry investigated the chemical-research features of the problem, and sent one of its expert fruit chemists to Sicily to study the local methods for the utilization of the lemon crop. When this chemist returned a laboratory was established at Los Angeles, California, for the purpose of investigating all problems relating to the utilization of lemons, oranges, peaches, apricots, and numerous other fruits and vegetables.

The citrus work of the Los Angeles laboratory has resulted in the development of technical processes for the manufacture of citric acid, lemon and orange oil, pectin, marmalades, stock feeds and other valuable by-products. Citric acid is extensively used in making soft drink beverages, drug preparations and other products; lemon and orange oils are used for flavoring; pectin, the substance which causes the juices of some fruits to jell, is employed in large quantities as an aid in making jellies, jams, etc., from fruits that lack this jelly-making property.

The first work in the industrial application of these laboratory studies upon citrus by-products was done by non-agricultural capital and people not so directly interested in the success of the enterprise as the citrus growers. When the growers organized themselves, they put their cooperative organization seriously into the by-product business. How well they succeeded is seen from the following: At one growers' cooperative by-products plant the gross business in citric acid alone amounted to as much as \$400,000 in a single year. The cooperative plant does not stop when it has extracted the chemicals. One plant used to pay a man \$100 a month to cart the pulp away and get rid of it; several years later it processed the pulp and sold it for stock feed for more than \$40,000 a year.

The citrus cooperative not only dragged a great fruit industry out of the shadow of bankruptcy; but it helped to make the United States independent of foreign sources for its lemon oil, citric acid, and pectin. Incidentally, it has shown the American farmer what he can do with a business problem of the first magnitude when he organizes and gets the best talent and brains he can find for solving it.

#### Economic Savings Effected

In 1929, when the campaign to eradicate the Mediterranean fruit fly was in full swing, Department scientists developed a way to sterilize citrus fruit by heat. This permitted the orderly marketing of citrus fruit grown in the infected area and saved millions to growers.

In helping farmers to fight insects, the Department has been active in developing two valuable insecticides, rotenone and potassium hexafluoraluminate. The latter has given good results against the codling moth.



A calcium salt, once so rare that it cost \$150 a pound, now may be had for 50 cents a pound because of recent work by the Department's chemists. In looking for molds to produce tartaric acid, they examined 149 without results. The 150th unexpectedly produced gluconic acid. This is now used in making calcium gluconate, the only calcium salt that can be injected between the muscles, without causing abscesses, in treating human diseases.

New vat dyes which permit the dye industry to meet competition from abroad, and to use cotton and artificial silk to better advantage, are in wide use, because the Department some years ago synthesized an entire new series of vat dye intermediates.

The Department has shown that removing the fine dirt and water-soluble material left in the crude pine gum by present-day processes gives rosin of a better grade and of higher value to industry.

The Department has determined that minute traces of noxious gases in the atmosphere play a major part in the deterioration of leather subjected to long use such as book bindings, upholstery, harness and similar articles and has indicated the best methods for retarding such deterioration.

Cheap nitrogen from air produced by a synthetic ammonia process in many American plants, is a reality in large part because of research in the Department. This successful development has resulted in the collapse of the foreign monopoly in nitrogen fertilizers and the United States is well on the road to independence in its requirements for fertilizer raw materials. Indeed, the Department's fertilizer studies have been extraordinarily productive in the last few years and as a result we have better and cheaper fertilizers than ever before. They have developed improved methods for phosphate production from United States deposits and have resulted in greatly improved methods for producing phosphoric acid by the use of the electric furnace and the fuel-fired blast furnace, the product being suitable not only for fertilizer production but also for food and technical products. They have shown the advantage of fertilizers containing higher percentages of plant food than heretofore ordinarily used and new products of this character are now available to the farmers. They have shown how profitable crops can be grown on certain non-acid soils by the application of manganese sulphate and other heavy metals. Areas of apparently fertile land in the Florida glades failed to respond to ordinary commercial fertilizers. Our chemists found that these soils were deficient in manganese. When this was supplied in the proper amounts, profitable crops of tomatoes, potatoes, beans, and other vegetables resulted.

Acting on investigations by the Department, sugar beet growers have recently been enabled to increase their yields of sugar beets by several tons per acre with small applications of phosphatic fertilizers. From a single carload of fertilizer in Colorado in 1923, following the department's experimental demonstration of profitable results, the tonnage of fertilizer used has steadily grown throughout the sugar beet territory as the result of the work and today the fertilizer consumed in the sugar beet territory has reached considerable proportions. With an average increase of three



tons of beets per acre, at \$6 per ton, the value of the crop will be increased by about five million dollars annually, at a cost of approximately seven hundred thousand dollars for fertilizer.

Strawberry growers in North Carolina last year increased their yields by 400 to 500 quarts per acre, and their average profit by \$75 an acre, through the use of fertilizing methods recommended by this Department.

Western fruit growers use methods developed in the Department for cleaning fruit of spray residues.

The Department was the first scientific organization to demonstrate that resistance to disease in plants is a genetic character, and that resistant qualities can be bred into or out of plants. Wilt resistant cottons and melons were the first practical output.

The San Jose scale, an introduced pest from China, was rapidly destroying the deciduous fruit orchards of the country - peach, pear, apple, etc. - as well as attacking many ornamentals. The Department's scientists devised control measures which made possible the continuance and rapid development of the commercial production of these fruits.

The Mexican bean beetle at first caused almost complete destruction of the bean crop. This pest has now been brought under commercial control as a result of the work of the Department's entomologists.

Not long ago the Bureau of Dairy Industry discovered how to condense skim milk so as to make the product self-preserving. As a result, skim milk can now be converted readily into concentrated sour skim milk in which form it can be preserved and transported. Manufacturers of concentrated sour skim milk provide the butter maker, the city milk dealer, and others with a convenient and practical means of utilizing one of the most important by-products of the dairy industry. About 75 million pounds of skim milk annually are now converted, by the bureau's process, into concentrated sour skim milk.

Here is one attempt to place a money value on research. An analysis was recently made of 20 continuing projects in insect pest control: the projects cost \$300,000 a year; they result in saving crops that are worth \$69,500,000 a year.

Ethylene oxide, the use of which as an insecticidal fumigant was discovered by the Department in 1927; is made more effective when mixed with carbon dioxide, and also is free from fire or explosion hazard. This fumigant is used in the fumigation of stored grain, foodstuffs, and other commodities. Following a hearing before the examiner of interferences of the United States Patent Office, in which the priority of the Department in the use of ethylene oxide as a fumigant was upheld against the claims of certain German inventors, a public-service patent for the discovery was issued to two members of the Department. Thus the fumigant was made available to all American citizens, and its wide use encouraged.



## Triumphs in Animal Disease Research and Service

Research in the Bureau of Animal Industry developed last year a simplified test for pullorum disease, one of the most serious and costly poultry diseases in this country. The test, which can be made within a minute or two, shows the presence or absence of the disease. Poultrymen have long needed such a test.

Another recent research triumph in the same bureau was the discovery of a way to control the liver fluke in sheep. This parasite has caused much loss in California and other Western States. Investigators found that the liver fluke spends part of its life cycle in a certain snail that lives in wet pastures and along the banks of water courses and irrigation canals. When such areas are treated with copper sulphate, a chemical extremely poisonous even in minute quantities to snails, the life cycle of the parasite is ended. As a result of this discovery, sheep raising in the areas affected has been re-established on a safe basis.

Big savings to the hog industry have come from the bureau's discovery that roundworms in swine can be controlled by preventing newly born pigs from swallowing the microscopic worm eggs commonly found in old hog lots and on the bodies and udders of sows. This innovation reduces mortality among the pigs, hastens their maturity, and saves feed. The new practice has been widely adopted in the principal hog States.

In a recent practical test nineteen farmers using the recommended swine sanitation system raised pigs ready for market fifty days earlier and weighing on the average 29 pounds more than pigs raised by farmers not using the system. This practice was taken up so rapidly by Iowa farmers that the peak marketing period of the spring pig crop in Iowa advanced considerably.

## Fire and Explosion Risks Lessened

Dust explosions are a hazard in 28,000 American industrial plants. This Department, the only Government agency studying dust explosions in such plants and in agricultural operations, is the principal source of technical information on the subject. It has found that grain dust will not explode in an atmosphere containing 12 per cent or less oxygen, provided the remainder consists of an inert gas such as carbon dioxide. It has developed methods of using inert gas in connection with grain grinding, conveying, and storing operations. In this way losses of life and property from dust explosions have been reduced.

Government chemists found that the dust from grain smut is extremely explosive and that sparks generated by the friction of machinery frequently set it off. It is now possible to prevent these explosions in threshing machinery. It has also been determined that a great variety of dusts will explode; this information is invaluable to farmers, grain handlers, and manufacturers. Explosions in elevators and factories have caused millions of dollars damage annually, and have been responsible for the loss of hundreds of lives.

Demonstrations, showing how dust explosion pressures may be released without damaging the buildings in which they occur, were conducted recently in a miniature factory in a series of 10 explosion tests at the Arlington



farm of the United States Department of Agriculture by the Chemical Engineering Division of the Bureau of Chemistry and Soils.

### Discoveries About New Insecticides

The Department recently developed a synthetic organic compound which is more toxic than nicotine when sprayed upon aphids. Nicotine, one of the most valuable insecticides used by orchardists, truck-crop growers, nurserymen, and florists, is not available in sufficient supply. The new synthetic substitute is called neonicotine. One of the largest manufacturers of coal-tar products is making an insecticide which contains neonicotine as its active ingredient. It was found recently that a common Russian weed, Anabasis aphylla, contains as much as 2 to 3 per cent neonicotine and related alkaloids. Efforts are being made to introduce the cultivation of this plant into the United States.

Determination of the complete chemical structure of rotenone was announced April 13, 1932. Chemists of the Department hope that rotenone can be developed ultimately into the insecticide most nearly approaching the ideal. With a knowledge of the structure of rotenone and associated compounds, said Doctor Browne, it will be possible to attempt to synthesize rotenone as a chemical product instead of being forced to extract it from vegetable sources. This new knowledge may also permit the synthesis of other compounds of analagous make-up which are likely to possess valuable insecticidal properties.

### Other Important Discoveries

The rare and expensive biochemical product, asparagin, formerly obtainable only by importation from Europe, can now be produced in the United States on a commercial basis, as a result of research in the Department. Dr. M. Dorset, Chief of the Biochemic Division of the Bureau of Animal Industry, reported the successful production of asparagin in the division's laboratory and the receipt of a shipment of the chemical as produced by the first firm to undertake its manufacture commercially.

A large proportion of field-run sweetpotatoes (the second largest vegetable crop in the U. S.) grown for market is graded out as culls (over-size and undersize) and is largely wasted. In 1931 this proportion ran up to 50 per cent in some localities, due to unusually rigorous grading. The Bureau of Chemistry and Soils has recently devised a means of producing white starch of highest quality from cull sweetpotatoes. This starch is suitable for use in the cotton textile industry, for which purpose large quantities of white potato starch are imported, principally from Holland and Germany, in spite of a duty of 2 1/4 cents per pound. An immediate market is thus provided by displacing imported potato starch at competitive quality and price. The utilization of sweetpotato culls at a price commensurate with that which could be paid for starch production would increase the return to growers by some \$3,000,000 annually, this estimate being based only on shipments of market grade sweetpotatoes.



Sugarcane for production of cane sirup and sorghum cane for production of sorghum sirup are grown on many thousands of farms in the United States and constitute substantial cash crops. About 60 per cent of the total production is marketed. The price obtained by the farmer varies by over 100 per cent, depending on the quality. The best price is obtained only for sirup of high enough grade to be sold direct to the consumer. Sirup of lower grade can be used only as a raw material for blending purposes. An improvement in methods of production so that all, or nearly all, of the sirup produced is of satisfactory quality to meet market demands will result in an estimated increase in return to growers of about \$3,000,000 annually. A great stride forward to a solution of this problem has been made through methods developed recently by the Bureau of Chemistry and Soils.

The Oil, Fat and Wax Laboratory of the Department is recognized as the American authority in this field. An outstanding contribution has been the numerous investigations on the composition of both the commercially important and the little known American vegetable oils, with a view to their more efficient utilization. The results of the study on the keeping quality of crude oils in storage have shown the oil miller how to handle his product with a minimum of loss through spoilage. This investigation alone has resulted in an annual saving of many thousands of dollars to the industry.

The department has investigated the food value of a large number of vegetable proteins. Proteins are the muscle-forming constituents of foods. The proteins of some of our most important grains, for example, are so deficient in certain constituents that animals will not grow, or live long, if they get no other protein in their rations. Other feeds have these same constituents in abundance. These investigations have enabled the farmer to make the proper selections and combinations which will give the greatest return in the feeding of farm animals, and in the economic utilization of his crops. The results of these chemical investigations, and work with small experimental animals have directed the course of investigations with farm animals in agricultural experiment stations.

For the past 14 years studies on vitamins have been in progress in the Department. These studies have been concerned chiefly with the distribution of vitamins in nature and with the effect of commercial processes and practices on the vitamin content of foods and feeding stuffs. The demonstration that fish oils produced on the Pacific coast in enormous quantities are good sources of vitamin D, which was the result of a co-operative study with the Bureau of Fisheries, has already led to the development of a large industry which is particularly beneficial to the poultry growers in the western States. About 10 years ago it was shown that vitamin A is not affected by commercial freezing of eggs. These studies have been extended to the quick-freezing methods which have been developed in recent years. It has been shown that oranges from trees heavily sprayed with arsenicals are markedly inferior to normal fruit in vitamin C content. The rate at which vitamin D disappears when cod liver oil is mixed with poultry rations depends upon the nature of the inorganic constituents present. Other findings of equal importance to agriculture have resulted from these investigations.



### Agricultural Engineering

To help the farmers in the New England States to combat the European corn borer more easily and economically, the Bureau of Agricultural Engineering, of the United States Department of Agriculture, is demonstrating in that section the use of binders with low-cutting attachments, and of special short-handle hoes for cutting low by hand. The work is carried on cooperatively with the Plant Quarantine and Control Administration and the Bureau of Entomology, and has been under way for about two months.

According to the preliminary announcements of the 1930 drainage census, issued by the Bureau of the Census, more than \$682,000,000 is invested in drainage enterprises -- largely open ditches. These ditches drain much of the best agricultural land in the country which in its original condition was of little value for agricultural purposes. To obtain a satisfactory return from this investment in drainage, it is essential that the ditches be maintained so that they will operate efficiently and give the service for which they were designed. The Bureau of Agricultural Engineering has developed equipment that, under most conditions, materially reduces the cost of maintaining ditches of various sizes.

Engineers of the Bureau have invented and taken out public patents on processes and equipment for drying seed cotton which have proved of material benefit in cleaning, extracting and ginning operations. These improvements have made possible a continuous operation of gins in all kinds of weather and have increased the capacity of cotton gins. The salable value of the cotton so dried has been increased from 60 cents to \$5.00 per bale. The cost of the vertical drier, developed by the engineers, is about one-third the cost of commercial driers of the same capacity. Last year about 35,000 bales were dried by this basic process, and present indications are that many vertical type driers will be constructed this year.

A beet cross-blocker has been developed by the engineers for use in planting sugar beets. It permits of uniform spacing so that the plants may be cross cultivated and eliminates a large amount of hand labor.

A fertilizer attachment for beet, cotton and potato planters has been devised by the Bureau's engineers for placing the fertilizer in various locations with respect to the seed. With this attachment the fertilizer is so placed as to give the maximum benefit to the crop as weather, soil and crop conditions may dictate.

A cotton seed planter with a variable depth attachment has been invented by the engineers. It tends to insure a fair stand of cotton by placing at least part of the seed at the optimum depth which is determined by weather and other conditions.

For use on sloping ground, a system of angle iron anti-skid rings for cultivators and other light machines has been worked out. These attachments make efficient cultivation possible on comparatively steep hillsides, and are especially useful on terraced lands.



A portable field burner has been developed by engineers of the Bureau for use in controlling the pea aphid in alfalfa. By using this burner a good stand of alfalfa may be obtained in infested areas.

Two methods of uniformly distributing poison grasshopper bait by mechanical means have been worked out. One is a reconstructed endgate seeder and the other an attachment for a lime spreader.

#### SERVICES GROWING OUT OF RESEARCH

Campaigns to control or eradicate certain plant diseases are conducted by the United States Department of Agriculture in cooperation with the authorities of certain States. Following are some examples of the resulting economic gains:

Control of black rot of grapes in the eastern vineyards has been effected; also the eradication and practical elimination of blue mold decay of oranges in transit, particularly from the southwest to the eastern markets.

Control of brown rot of peaches, plums, and cherries in the Northwest by spray methods has been established.

Control measures through seed treatment of tuber-borne diseases, such as scab, black scurf, and black leg, and through breeding and selection of types resistant to the degeneration diseases, particularly mosaic and related virus diseases, have made possible the certification of disease-free potatoes for planting purposes.

Several wilt-resistant varieties of tomatoes have been distributed, some of these being resistant to other diseases also. Better methods of spraying for controlling leaf-spot and improved field sanitation for controlling blight have been developed.

Methods of spraying for controlling powdery mildew of apples in the Northwest have been satisfactorily established.

Rust-resistant strains of asparagus have been developed in cooperation with the Massachusetts Agricultural Experiment Station and the Asparagus Growers' Association and have been distributed generally throughout the country. These strains have displaced previously grown susceptible types so that losses from rust have been eliminated and the quality of asparagus generally improved.

Control of neck-rot and smudge diseases of onions has been established by artificial curing and by formaldehyde application.

Substitution of mosaic-resistant sugar cane for susceptible varieties has maintained the production of sugar cane in the southeastern United States. Mosaic disease was discovered in 1919 in a small part of the sugar cane area in eastern Louisiana. It spread rapidly through that State and into other sugar cane growing States. Great areas of cane lands passed out



of cultivation; sugar mills remained idle; and the sugar cane industry faced collapse. Mosaic disease can not as yet be cured because its nature is unknown. Accordingly, the Department undertook to develop resistant varieties. It imported strains known to be tolerant of the mosaic disease. These varieties, propagated from cuttings, were planted in 1928 on 135,000 acres in Louisiana. In 1929 the acreage planted to sugar cane compared favorably with the acreage grown before the appearance of mosaic disease.

In cooperation with the Gulf States the Department undertook the eradication of the citrus canker disease. The citrus industry of the Southeast was saved from what appeared at one time to be an uncontrollable and highly destructive bacterial disease of citrus leaves, twigs, and fruits. This campaign, begun in 1914, now appears to be approaching complete success. None of the disease is now known to occur in the United States.

Similar campaigns for the control of white pine blister rust, both in the eastern and western parts of the United States, are under way.

The campaign to reduce the heavy epidemics of black-stem rust in the spring wheat area of the Northwest by eradication of the common barberry bush has been making rapid progress.

Seed treatment of wheat has been established to reduce smut infections; and resistant varieties, particularly against rust, have been bred.

#### Preventing the Introduction and Spread of Pests

The Department, through its plant quarantine service at the seaports and along the borders of the United States, inspects shipment of fruits, vegetables, grains, nursery stock and other materials that might bring in insect pests and plant diseases. Embargoes are enforced against products which cannot be inspected thoroughly. Since this work was established in 1912, the invasion of new pests which were arriving from other parts of the world with alarming frequency has been practically stopped. Only one major insect pest of primary importance from outside of North America is known to have gained entrance to this country and to have established itself during the twenty-year period since the plant quarantine act was passed. That pest was the Mediterranean fruit fly. It was fought so promptly that its eradication appears to have been accomplished. The pests that arrived within a few years before the plant quarantine act was passed included the chestnut blight, the citrus canker, the white pine blister rust, the oriental fruit moth, the European corn borer, the Japanese beetle, and the potato wart.

The port inspection service constantly intercepted dangerous insect pests and plant diseases, many of which are new to this country. Among these interceptions are the Mediterranean fruit fly, West Indian fruit fly, Mexican fruit fly, citrus black fly, melon fly, pink bollworm of cotton, turnip gall weevil, avocado weevil, sweetpotato weevil, gipsy moth, brown-tail moth, gold-tail moth, dagger moth, European tussock moth, sawflies, Lima bean pod borer, citrus canker, rice smut, and red rot of sugarcane.



Among the major accomplishments under the plant quarantine act may be listed the following:

The pink bollworm of cotton, an insect as destructive as the boll weevil, has been eliminated from extensive areas of eastern Texas and Louisiana, and from smaller areas at Hearne, Beaumont, Ennis, and Marilee, Tex. The main Cotton Belt has been kept free from this pest. The pink bollworm is now confined to western Texas, New Mexico, and Arizona, where the infestation is connected with an extensive and serious infestation in Mexico.

The Mediterranean fruit fly, perhaps the worst known fruit pest, which was discovered at Orlando, Fla., April 6, 1929, and subsequently found in 20 counties, was attacked by the Department and the State in the most vigorous and extensive insect extermination campaign ever attempted. Although the fruit fly had become established on over 1,000 properties, the eradication was apparently a complete success. No specimens have been found since November, 1930.

The number of palms infested with the *Parlatoria* date scale in California and Arizona has been reduced from 1,590 in 1929 to 232 in 1931. Total eradication is anticipated by 1935. This pest is so serious that the success of the promising young industry of date culture in the United States may depend on the insect's total extermination.

The gipsy moth, an important pest of fruit and shade trees, was completely eliminated from an area of more than 400 square miles in New Jersey. The importance of this accomplishment is indicated by the fact that in New England, the States and local town government are spending more than a million dollars a year to keep the insect from stripping the forests and shade trees. Through the establishment and maintenance of a barrier zone, a strip of territory 20 to 30 miles wide along the western border of New England and eastern border of New York, in conjunction with quarantine enforcement, the infestation in New England has been prevented from spreading west of the eastern boundary of the barrier zone.

The spread of the Japanese beetle to distant points in shipments of plants with soil has been prevented. Meanwhile, although natural spread and dissemination through train and automobile movement have carried the insect about 300 miles from its point of original introduction, the delay in the extension of infestation to other parts of the United States has made possible the working out of economical control measures and the introduction of parasites from foreign countries.

The Mexican fruit worm, a serious pest of grapefruit and oranges in Mexico, has been prevented from becoming firmly established in the United States. The occasional local outbreaks in Texas since 1927 have been stamped out as they arose and have been kept from spreading to other fruit-growing sections of the United States.

By means of road stations and by checking on mail, express and freight, thousands of shipments subject to quarantine restrictions, many of them infested, have been intercepted and turned back. Injurious pests have thus been kept out of uninfested localities.



For ten years the spread of the European corn borer has been kept down to an average of less than twenty-five miles a year and the insect has been prevented from reaching distant uninfested localities in corn shipments. Parasites of the borer have been introduced from foreign countries and control measures worked out. The dissemination of this pest has been so delayed that when it reaches the most important corn-producing sections the growers may be able to cope with it successfully.

The satin moth, which attacks poplar and willow trees, has by quarantine measures been prevented for ten years from spreading from the New England States and Washington, to those sections of the United States in which these trees are of principal importance.

The *Thurberia* weevil, a native insect better adapted than the boll weevil to attacking cotton in dry hot districts, has been prevented from escaping from its native home in southern Arizona and reaching those western sections of the cotton belt where it would be especially injurious.

The insect pests and plant diseases of Hawaii, Porto Rico and the Philippine Islands are largely different from those of the continental United States. By restricting and inspecting shipments to and from the territories and possessions of the United States, the insular pests have been prevented from reaching the continent and vice versa.

#### Services to the Dairy Industry

For a number of years the Bureau of Dairy Industry has been helping creamery managers establish a system of buying cream on the basis of its quality, or in other words on the basis of the grade of butter that could be made from it. The net result has been better butter, and better prices for it, in every creamery that has adopted the practice; and furthermore, the premium received for quality butter has enabled the creameries to pay the farmer higher prices for his cream. In Tennessee, where the system was introduced in a cooperative creamery several years ago, the success in improving the quality of butter led other creameries in the State to adopt the same system of grading their cream and paying for it on the basis of its quality. At first there was some difficulty in obtaining a price for the butter in keeping with its grade, but this difficulty was overcome for six local creameries when the Bureau of Dairy Industry made arrangements for them to cooperate in shipping their butter in car lots to an eastern market, each churning to be paid for according to grade or score. A bureau specialist was assigned to the job of scoring each churning and reporting his criticisms and recommendations for improvement to each creamery. Forty carloads of butter were shipped under this arrangement, and the six creameries received \$36,055.77 more for 835,138 pounds of their butter than they would have received if they had not improved its quality.

The Bureau of Dairy Industry also helped cheese factories in 13 States in the South and Middle West in improving the method of making Cheddar cheese. As a result many factories, particularly in the Southern States where cheese making is a comparatively new industry, are now turning out No. 1 quality cheese. At one factory the sales value of the cheese produced increased at the rate of \$4,000 a year.



An improved method of making cottage cheese has been demonstrated each year in an increasing number of factories. In 1918 when the work was first started on a large scale, we were producing only about 28 million pounds of cottage cheese, whereas last year we produced and consumed more than 97 million pounds.

In the last two years bureau specialists have demonstrated the bureau's improved method of making casein in more than 200 factories, with the result that many of them are now making a uniformly high-quality casein suitable for the paper-coating industry which is the largest consumer of casein.

### Economic Services

Farmers need economic information as well as help in combating insect and other pests and in improving their field crops and livestock. Lacking data on markets and prices, the farmer works in the dark, with small chance to make a profit. This fact, though generally recognized, was formerly not taken sufficiently into account in public services for agriculture. Research was largely concentrated on the technic of production. As production per acre and per man increased and the farm area expanded, surplus problems grew more pressing. Action became necessary to effect a better regulation of supply to demand, and a more orderly flow of production into consumption.

The first requirement was more information about production, stocks, and consumption demands. Progress in statistical science made it possible to satisfy this requirement. Accordingly, the Department developed extensive and varied economic services, in which research was combined with the regular gathering of crop and market data, and with numerous related services, such as commodity grading and standardization, shipping and receiving point inspection of farm commodities, seed verification, price analysis, and "outlook" reporting. Farm-management studies were undertaken, whereby general economic information was related to the needs of particular localities and particular farms. In short, the Department began systematically to help the farmer look ahead, and the work soon became a major departmental activity.

Economic information put out by the Department is primarily for the farmer, though useful to all persons having dealings with agriculture. Reliable information about market prospects helps the farmer to adjust his acreage and his livestock breeding intelligently, and to join with other farmers in concerted action to stabilize production. It also lessens the influence of speculation in the agricultural commodity markets. Prices stick closer to the supply and demand line when the facts about supply and demand are accurately and generally known. There is then less room for the influence of uninformed opinion or deliberate misinformation. Ultimately, prices depend on tangible and measurable elements in the supply and demand equation. Among these elements production is the most important, and the measurement of production has attained a high degree of accuracy. Progress has been made also in the measurement of demand, which depends on such factors as the general price level, the state of business and employment, and the possibility of substituting one commodity for another in various uses. Light on these factors is a powerful influence in reducing price fluctuations.



Increasing efficiency in agriculture and the existence of large surpluses of the major farm products point to the probability that for some years little or no expansion of our farming area will be required. American agriculture approaches a turning point. There is urgent need for a readjustment in our land policy. This department directs much attention to the study of land utilization. It classifies the soils of the country and studies their properties. It investigates the extent, causes and prevention of erosion. It studies drainage, irrigation, land clearing, forest pathology, silviculture, range utilization, and related problems. It deals also with the economic aspects of land utilization. As the necessary basis of rural planning, it seeks to determine for specific areas what uses of land are most economical. Knowledge thus gained is indispensable in coping with the serious land problems that have been brought to a head by the prevailing economic depression.

The administration of the Perishable Agricultural Commodities Act has become one of the most important services to fruit and vegetable growers and dealers. There have been bitter controversies between shippers and buyers of consigned products for many years. Numerous efforts have been made to develop means of settling such difficulties. Finally in 1930, Congress passed the Perishable Agricultural Commodities Act which authorizes the Secretary of Agriculture to license all dealers of perishables, and to regulate their method of operation. As a result of this act, over 17,000 licenses have been issued; hundreds of cases in dispute have been adjusted; and the trade has been relieved of its most difficult problem; namely, the settlement of differences without recourse to the courts.

The development of the outlook service by the Bureau of Agricultural Economics has been remarkable. In recent years it has become one of the most useful forms of agricultural information. This service brings together all available facts on the outlook for each commodity, and summarizes and interprets these facts so that the producer may know something about the economic prospect for his crop. From a small beginning, this service has grown until it now covers more than fifty of the principal crops and classes of livestock. The service has been expanded by the Extension Service until millions of farmers now receive some form of information on the agricultural outlook. Thousands have participated in meetings for the discussion of outlook information during the past year. While it is impossible to measure results accurately, leaders in the production of many farm products declare that outlook information has enabled them to increase their income, as well as to avoid serious losses.

Foreign representatives of the Bureau of Agricultural Economics, who are located in the market centers of our principal competing countries, measure the extent of the competition which our producers are likely to meet in these markets. They study foreign consumption trends of such American farm products as cotton, grain, fruit, etc., to learn what grades of these products are most in demand. They collect information regarding restrictions to trade, tariffs, embargoes, and so forth. This information is brought to American shippers by the department and enables them to meet foreign competition more effectively. By utilizing the information of this service, exporters of our farm products have overcome obstacles in foreign trade, which otherwise they would have been unable to meet.



The farmers' credit problems, mortgage indebtedness, taxation, and similar problems, have been analyzed and measured during recent years by the Bureau of Agricultural Economics. The results of this analysis may not benefit farmers directly but they have been made the basis for determining national and State policies and legislation. Financial surveys of this sort can not be made effectively by private individuals. To be of use for the purposes mentioned, the facts should be assembled by an impartial, disinterested government agency. When legislative questions arise, an annual estimate of changes in farm land values, indebtedness, income, and so forth, forms a basis on which the farmer's position may be established in relation to other industries.

### Standardization and Inspection

Commodity standardization and inspection are among the Department's principal functions, although the establishment and use of uniform standards of quality for farm products is a comparatively recent development. Little had been accomplished in a national way in this field prior to 1913, but since that time much progress has been made. The development of national standards for farm products is essentially a process of evolution, for established trade practices yield slowly to the forces making for change and improvement. In large-scale marketing, however, such standardization is now universally recognized as a basic requirement. Whether or not the producer or the distributor is rewarded for the expense involved in making the necessary classification depends largely on his subsequent marketing practices. The standardization and inspection of farm products, when associated with a wise marketing policy in general, effect substantial savings.

### Regulatory Law Administration

The Department administers approximately 50 regulatory statutes. The most important are the laws regulating the occupancy and use of the national forests, the animal quarantine laws, the meat inspection act, the virus serum toxin act, the packers and stockyards act, the produce agency act, the perishable agricultural commodities act, the 28-hour law, the renovated butter act, the plant quarantine act, the food and drugs act, the tea importation act, the import milk act, the naval stores act, the caustic poison act, the insecticide and fungicide act, the seed importation act, the migratory bird treaty act, the Lacey act (affecting wild life), the Alaska game law, the cotton standards act, the grain standards act, the Federal warehouse act, the cotton futures act, and the grain futures act.

Like its other activities, the Department's regulatory work was developed to meet long-standing public needs or new conditions created by the progress of scientific knowledge and the growth of population and markets. It originated with the creation of the Bureau of Animal Industry in 1884, when Congress passed certain legislation to regulate traffic in livestock. Contagious pleuropneumonia was then prevalent among livestock in several States east of the Mississippi River, and several European countries had refused to admit livestock from the United States except for immediate slaughter. Under Congressional authority quarantine regulations were imposed and disease-control methods investigated. These measures finally gained the removal of the European restrictions.



### Results from Food and Drug Law Enforcement

Before the passage of the Federal food and drugs act, the consumer had little faith in commercially packed foods. But as the housewife learned that enforcement of the law rapidly removed from trade such goods as had formerly defrauded and offended her, confidence in the fruits of the canning and packing industries was built up. The annual value of the output of these industries these days is approximately 12 billion dollars. The wholesomeness of the vast bulk of manufactured foods on the market today is assured. Inspectors of the Department constantly travel in the field, visit manufacturing plants, study production processes, and institute action where violations of the law are encountered. Interstate shipments and importations of all foods and drugs are subject to the food and drugs act. Such foods include canned foods, fresh fish, poultry, eggs, butter, fruits and vegetables. The Department is concerned with seeing that fruits and vegetables contain no residue of arsenic or other spray materials that might be harmful to health. It is likewise concerned to keep decomposed eggs or poultry, fish containing parasites, or butter containing less than the legal requirement of butterfat from reaching the consumer.

Since the passage of the Federal food and drugs act, the Department has initiated legal procedure against nearly 23,000 violations. Many of these have involved manufacturers and shippers of impure, spurious, or mislabeled drugs and medicines. The survey of anaesthetic ether is an important task. Whereas, in 1926, 34 per cent of the cans of ether examined were not of U. S. Pharmacopoeia quality, only 5 per cent of ether examined in 1930 proved to be below standard and at present sub-standard samples are rarely discovered. Shipments of drug products of such vital importance as ergot, digitalis, insulin, and potent drugs of every description are sampled and examined by the Department every day with the object of assuring the public of pure and honestly labeled goods. Hundreds of drugs and pharmaceuticals, relied upon in cases of illness, are under constant surveillance.

Through its regulations of traffic in livestock remedies, the Department definitely aids the farmer in obtaining goods which may be depended upon to help him in the treatment of certain diseases of farm stock. The Department has removed from the American market countless preparations, recommended for livestock diseases, which were totally worthless.

Such protection costs the American consumer about one cent per year.

### Achievements in Forestry

One-fourth the land area of the United States is forest land. To make it useful is a great public problem. It is really an extension of the agricultural problem, and interwoven with it.

The Department of Agriculture administers the National Forests, through one of its bureaus, the Forest Service. The National Forests are given better protection against fire than ever before, through great effort to find and apply the most efficient and most economical means of



control. The Forests are extensively opened up through road and trail construction, they are increased in number and size to make them a well-rounded national system, and their timber, water, forage, and recreational resources are made available and at the same time are conserved through careful, skillful management.

In the interest of better use of all the forest resources of the country, public and private, the Forest Service is doing a work on behalf of practical forestry like that of other bureaus of the Department of Agriculture on behalf of progress in farming, through a system of regional forest experiment stations and a rounded program of research. It cooperates with the States in maintaining systems of protection against forest fires on private and State lands, and in producing and distributing forest planting stock to aid farmers in reforestation. Through research, cooperation, administration, and public education combined it has advanced both the practice of forestry and the general understanding of what forestry is.

#### Aiding the Home Maker

A large proportion of the food, textiles, and other products of Agriculture find their way into the home. How economically and effectively they are utilized there has important bearing on the health of the nation as well as on the business of agriculture. Nobody questions the strategic position of the home in the economics of consumption. The Department of Agriculture pioneered in research in this field. Dietitians and investigators in many phases of the food question use the tables of chemical composition of food materials compiled by this Department. The War brought many conspicuous examples of the need for food facts. The Inter-Allied Food Commission based its recommendations in large measure on the dietary standards and food research of this Department. In the present economic crisis the Bureau of Home Economics gives to individuals and relief agencies information on low-cost diets. When food money is limited, greater care must be given to selection of supplies so as to prevent malnutrition. The Bureau shows how to divide the food dollar among the different groups of food, so as to provide a well-balanced diet. It issues a weekly news release calling attention to the nutritive value of the cheaper, more abundant foods giving menus and recipes for appetizing meals at low cost. The definite relation of adequate food to child health is emphasized in popular and technical publications.

Cooperative studies on the quality of foodstuffs and textile fibers yield important results to both producers and consumers. As part of a nation-wide cooperative project on the influence of various production factors on the palatability of meats, the bureau cooks cuts from experimental animals for testing and judging. As a by-product of this research, which is designed primarily to assist the livestock industry in better meat production, home methods of cooking meats are developed. Similar work is under way on other foods.

Studies in cooperation with the Bureaus of Plant Industry and Animal Industry determine the value of different grades of cotton and wool in finished fabrics. Fibers of representative types are followed from the cotton field or the shearing shed, through spinning and weaving in the



mill, to their use by the consumer. Thus a record is obtained of the use of certain textile fibers for certain purposes. The information is furnished to the grower to guide him in producing cotton or wool, and to the consumer as a help in selecting the textiles best suited to particular needs.

#### Extension of Research Findings

When the Smith-Lever act setting up a nation-wide organization for better agricultural education was passed in 1914, it was declared in Congress that the Department and the State agricultural colleges and experiment stations had knowledge 25 years in advance of average farm practice. Today the gap is much narrower. Agricultural science is put into practice probably quicker and more generally in the United States than in any other country. This is largely a result of extension and informational work. It is naturally difficult to measure the practical outcome of educational activities, but evidence accumulates that the work pays.

#### Controlling Injurious Wild Animals

Coyotes, wolves, mountain lions, bobcats, and some stock-killing bears cause an annual loss of more than \$20,000,000. This figure allows for the inroads of predatory animals on game and on ground-nesting and insectivorous birds, as well as on sheep and lambs, cattle, pigs, and poultry. In the fiscal year 1916 the Bureau of Biological Survey began to build up a field force for the control of predatory animals. Predatory-animal districts, each in charge of an experienced leader, were organized in the principal western livestock-producing States. Hunters are not paid on a bounty system, but devote their entire time to the work. Poison campaigns have been undertaken and made effective. The result is a large reduction in the number of coyotes and other predatory animals in the sections covered. Livestock losses have decreased correspondingly.

#### Meat-Inspection System

The Department maintains a comprehensive and effective meat-inspection system that is universally recognized. The system is responsible for the wholesomeness of Federally inspected meats and is virtually the basis for our considerable export trade in meats and meat food products. Without the guaranty of Federal inspection, most foreign markets would be closed to our meat products. Federal meat inspection is conducted at approximately 800 establishments in about 250 cities and towns. These figures vary slightly from year to year.

The inspected slaughter of food animals has ranged in recent years from about 70,000,000 to 75,000,000 head, with swine constituting about two-thirds of the total. Sheep rank next in the slaughter totals, with cattle, horses, and goats following. Horse meat is exported or used for feeding animals in zoological gardens, and on fox farms, and for similar purposes.

The economy of the Federal meat-inspection service is noteworthy. The average cost is between 6 and 7 cents per animal. This figure includes the cost of inspection before and after slaughter, the inspection of prod-



ucts and imported meats, supervision of labeling, inspection of the cars in which the meat is shipped, and laboratory analyses. Though Federal meat inspection is primarily for the protection of meat consumers, the results of post-mortem examinations help stockmen by furnishing information concerning diseases and ailments found in animals on the killing floor.

### Bovine-Tuberculosis Eradication

The extensive Federal-State task of eradicating tuberculosis from livestock is steadily progressing. The degree of infection among cattle was more than 4 per cent at the beginning of the campaign 13 years ago. The corresponding figure for 1932 was only 1.4 per cent. More than 13,000,000 cattle were tested during the last fiscal year, out of which number 203,778 proved to be tuberculous as indicated by their reaction to the tuberculin test. The elimination of these animals removed a menace to the public and to the livestock industry.

The method of area testing by which all the cattle in a given unit, generally a county, are tested within a short time again proved effective and economical. On June 1, 1932, a total of 1,422 counties (and 74 towns in Vermont) had completed one or more tests of all cattle within their borders, and had been officially designated as modified accredited areas. This term signified that bovine tuberculosis has been reduced to one-half of 1 per cent or less and that all reacting cattle have been removed. Seven entire States - North Carolina, Maine, Michigan, Indiana, Wisconsin, Ohio, and Idaho - have been freed of bovine tuberculosis by the area method.

Records of Federal meat inspection indicated further reduction in the number of cattle and hogs condemned as unfit for food because of tuberculosis. This reduction reflected important savings to livestock producers through reduced infection on farms. The benefit will continue, provided owners cooperate with livestock sanitary authorities in preventing reinfection.

Though it is impossible to set a money value on animal disease prevention, it can not be doubted that the value is enormous. In the five years 1926 to 1930, the number of cattle affected with disease or other abnormal conditions, in Federally inspected slaughter houses, decreased from 59 per thousand to 42 per thousand. Affected swine decreased from 142 per thousand in 1926 to 115 per thousand in 1930. Cattle known to be free of tuberculosis are worth several dollars a head more than non-tested cattle. Tuberculin testing in 1931, in which year more than 13 million cattle passed the test, meant an increase in value of probably \$50,000,000 or more. Hog cholera losses, which used to exceed 5 per cent of all hogs in former years, now are below 3 per cent. This is a direct result of hog cholera prevention methods developed by the Department.

### Federal Aid Road Work

Federal-aid road work progressed more rapidly in the fiscal year ending June 30, 1931, than in any preceding year. During the year 11,033 miles were completed as compared with 8,682 miles the preceding year. The mileage completed is composed of 7,939 miles of road improved for the first time with Federal aid, 3,082 miles previously improved but now raised to a higher type, and 12 miles of reconstructed road. Actual payments to the States amounted to \$133,340,000.



At the close of the fiscal year the projects under construction totaled 16,480 miles as compared with the 9,915 miles in progress at the end of the preceding year.

### WEATHER SERVICE

The weather affects practically every industry in the United States. It is especially important to agriculture, and may be called the farmers' working partner. A highly efficient and invaluable weather service for commerce, industry, aviation, and agriculture forms a part of the Department's work. Vast savings in property, and even in human life, are made possible by forecasts for aviation, through storm, flood, frost, and cold wave warnings, and in many other ways.

An illustration of the direct application of Weather Bureau work to agriculture is afforded by the service rendered to citrus growers in southern California the latter part of November, 1931. The fall had been warm and an early frost was not expected by the growers. Consequently an unusually large percentage of them had not placed their heaters in the groves up to the 20th of November, but two days later an unusually severe and damaging frost occurred. On the afternoon of November 20, 36 hours before the first firing was necessary, the fruit-frost officials of the Weather Bureau broadcast a warning by radio to all citrus growers in California that orchard heating would be necessary within 48 hours. At that time the weather was cloudy and mild, and many unsuspecting growers failed to listen-in on the broadcast. Fearing that this might be the case, officials of the fruit-frost service called, by phone, the manager of every citrus packing house in central and southern California, and gave personal warning of the impending low temperatures. The packing houses at once notified all growers in their respective vicinities. As a result, heaters were installed, filled, and made ready for lighting, with rush orders, on hundreds of acres of citrus groves, some growers working at top speed up to the time it was necessary to begin firing.

On May 4, 1932, in a letter of appreciation by the fruit growers to the Department, it was stated that literally millions of dollars in citrus fruit are saved through this inexpensive service of the Weather Bureau.

### RELATIONS WITH STATE EXPERIMENT STATIONS

Through its Office of Experiment Stations the Department maintains close relations with the agricultural experiment stations of the several States, as well as with those of Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands. The Federal government contributes annually about \$4,500,000 to these experiment stations, whose total funds are approximately \$13,000,000 annually. Although the Federal funds for the State stations are not expended by the Department itself, it is required by law to ascertain whether the expenditures as made by these stations are in accordance with the various Acts under which they are granted. In the discharge of this function, it endeavors to promote their efficiency by rendering advice and assistance, including the publication of the



Experiment Station Record, which reviews periodically the findings of agricultural research in this and other countries.

The Department also cooperates with the experiment stations in more than 1,000 research projects, or more than 15 per cent of the projects in which the stations are engaged. This cooperation economizes effort, coordinates different investigations, and prevents duplication of work.

The research in which the Department cooperates with the stations covers national, regional, and local problems. It has to do with the needs of the farm home and with rural-community matters as well as with the production, distribution, and sale of farm products. The results are disseminated by colleges and schools of agriculture, as well as in textbooks, treatises, and bulletins. Experiment station findings obtain wide publicity, also, through the rural press and the radio. They are translated into farm practice especially through the extension services of the different States.

#### WHAT IS ALL THIS WORTH TO THE NATION?

Many of these results would not have been achieved if the Federal Government had not gone into agricultural research. Agricultural research is socially valuable and yet not usually attractive to private enterprise. Few individuals or corporations have the public spirit, the scientific interests, the time or the money to do it well. It is a long-time activity, the rewards of which can not easily be monopolized. As a private enterprise, it usually does not pay. But it pays the community a thousandfold. Not to carry it on would mean neglecting one of the greatest sources of private and national wealth. Hence almost every one regards agricultural research as a legitimate public function.

And the foregoing are a few of the dividends the country draws from its investment in the United States Department of Agriculture. Much as we would like, for the sake of simplicity, to do it, we can not measure the dividend in dollars and cents. It is too widely diffused, too complex in character, for any such accounting. On each occasion when it has appeared in this country, the Department has stamped out foot-and-mouth disease of cattle. What is the cash value of that achievement? No one can say, because no one can tell how much damage the disease would have caused had it gained a foothold. What is the value of hog cholera control, of the eradication of bovine tuberculosis, of the eradication of the Mediterranean fruit fly, of livestock and grain grading, of weather forecasts and flood warnings, of plant disease prevention, of soil chemistry and soil surveys? It is incalculable both literally and figuratively.

This does not mean that it is unreal or intangible. On the contrary it is far more substantial than many things that the statistician deals with more easily. Consider, for instance, the effect of the Department's work on the farmer's costs of production. It is apparent to every intelligent producer, and yet extremely difficult to measure. Cost accounting, whether for individual farms or for agriculture as a whole, is a relatively undeveloped technique; but the influence of technology on production costs is there whether you measure it or not. Consumers as well as producers benefit. They get more and better products at lower prices. But one might as well try to measure the economic value of sun-



light. Pervading everything, it can not be isolated for statistical observation.

Still less easily measured is the effect of agricultural science upon the level of civilization. This is an advantage which must forever defy cash evaluation. Agricultural science developed in the department enters the general stream of science to stimulate and nourish the whole culture of mankind. By checking disease among plants and animals, it promotes health among human beings. By showing how heredity influences the lower forms of life, it indicates its human application. By controlling plant forms, it makes homes, farms, and cities <sup>more</sup> beautiful. If this were not done in just the way it is, it might not be done at all.

It is absurdly irrelevant to contend that the worth of the department's activities should be exactly measurable in profits to the farmer. Farmers can not monopolize; they can only share the resulting benefit. Frequently indeed, through unregulated competition and overproduction, they let the benefit go mainly to the consumer. But this affects merely the distribution, not the sum total of the benefit. Those who want the benefit destroyed, because the farmer does not get it all, have drawn the wrong conclusion. In the last analysis, the benefit is diffused throughout the entire structure of our civilization.

#### What Does the Work Cost?

The chart appended to this sketch of department activities shows the total expenditures charged to the Department of Agriculture for the fiscal year 1932. The net cash withdrawal from the Treasury was \$305,673,873. Did this all go for agriculture?

Nearly 70 per cent went for the building of the Nation's highways -- a total for this purpose of a little more than \$213,000,000.

About 3.67 per cent went for emergency relief loans which are being repaid. This was in no sense an ordinary expenditure of the department. Rather it was an extraordinary loan. That accounted for about \$11,222,000.

Exactly 5.26 per cent was made up of payments to the States for expenditure by them rather than directly by the department itself. Included in this group are payments for State experiment stations, State extension services, and forest fire prevention. The total was approximately \$16,074,000.

A little more than \$65,250,000 -- 21.35 per cent of the total -- was for the ordinary activities of the Department of Agriculture. But by no means was even this exclusively for farmers. Funds for weather services, food and drug law enforcement, forest conservation, meat inspection and so on -- all items clearly of general public interest -- were \$35,118,000.



Even the remainder, \$30,131,000 -- a little less than 10 per cent of the grand total -- was not for agriculture exclusively. As previously pointed out, agricultural research benefits all groups. Farmers merely share in the benefits. Work in the field of home economics benefits every one, and yet this activity is included in this final 10 per cent. Crop reports aid many industries as well as agriculture. Chemical research, as previously shown, is of benefit to the Nation as a whole.



(To accompany Chart No. 1-A--1932)

EXPENDITURES OF DEPARTMENT OF AGRICULTURE, FISCAL YEAR 1932

1. Roads:

(a) Regular Funds:

Federal Aid to States.....\$131,905,832

Forest Roads and Trails.....16,065,773

Total, Regular Road Funds, exclusive  
of Mount Vernon Highway.....147,971,605

(b) Emergency Relief and Construction Acts:

Federal Aid (Advances) to States.....58,912,433

Forest Roads and Trails.....2,087,692

Public-Land Highways.....1,953,273

Total, Emergency Road Funds.....62,953,398

(c) Mount Vernon Highway.....2,201,044

Total for Roads, as above.....\$213,126,047 69.72%

2. Emergency Relief Loans.....11,222,394 3.67%

3. Payments to States.(exclusive of Road Funds):

State Experiment Stations.....4,356,592

Extension Work.....8,633,248

Forestry Items, Including Forest Fire Pre-  
vention.....3,084,949

Total, Payments to States, as above.....16,074,789 5.26%

4. Ordinary Activities of Department:

(a) Some of larger items clearly of general  
public interest, as follows:

Weather Bureau (general).....2,503,338

Weather Bureau (for aviation).....1,433,025

Meat Inspection.....5,092,747

Food and Drug Laws.....1,634,733

Forest Service.....17,182,406

Bureau of Biological Survey.....2,033,768

Tuberculosis Eradication.....5,238,959

Total, above items.....35,118,976

11.49%

(b) Remaining ordinary activities, including  
many items of general public interest  
as well as items directly for benefit  
of agriculture.....30,131,667

9.86%

Total, Ordinary Activities, as above.....65,250,643 (21.35%)

5. Total, Department of Agriculture, All Purposes, 1932 (checks  
issued basis).....305,673,873 100.00%

Excess of prior-year checks paid in 1932 over current

checks outstanding.....+13,301,944

6. Actual Cash Withdrawals from Treasury.....318,975,817

Total Expenditures of Federal Government, 1932 (actual cash  
withdrawals from Treasury), exclusive of payments from

postal revenues.....\$5,006,590,305

Relation of Department of Agriculture expenditures to  
total expenditures of Government:

All Purposes, on basis of actual cash withdrawals(\$318,975,817)..6.37%

Deduct Roads, (\$213,126,047 covering checks issued in and for

1932, plus approximately \$12,500,000 covering prior-year

checks paid in 1932; total, \$225,626,047), leaving \$93,349,770....1.86%

Deduct Roads, Emergency Relief Loans, and Payments to

States (\$252,923,230), leaving \$66,052,587.....1.32%



CHART NO. I-A--1932. CLASSIFICATION OF TOTAL EXPENDITURES  
CHARGED TO DEPARTMENT OF AGRICULTURE, FISCAL YEAR 1932.

ACTUAL CASH WITHDRAWALS FROM THE TREASURY----\$ 318,975,817

EXCESS OF PRIOR-YEAR CHECKS PAID IN 1932

OVER CURRENT CHECKS OUTSTANDING-----+ 13,301,944

TOTAL FOR CHECKS ISSUED IN 1932-----305,673,873

